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PRELIMINARY TESTS OF CHLORINATED BENZAMIDES AS INSECTICIDES

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One hundred and twenty-eight chlorinated benzamides were tested as insecticides in the laboratory of this Bureau at Anaheim, Calif., during the period from February 1946 to August 1948. The Division of Insecticide Investigations supplied all samples. All compounds were tested as dusts against at least three species of insects; many of the more toxic materials were tested against six or seven species. The following species were used:

Alder flea beetle (Altica ambiens (Lec.))
Armyworm (Cirphis unipuncta (Haw.))
Cabbage aphid (Brevicoryne brassicae (L.))
California oakworm (Phryganidia californica Pack.)
Celery leaf tier (Phlyctaenia rubigalis (Guen.))
Citrus red mite (Paratetranychus citri (McG.))
Green dock beetle (Gastrophysa cyanea Melsh.)
Large milkweed bug (Oncopeltus fasciatus (Dall.))
Pea aphid (Macrosiphum pisi (Kltb.))
Two-spotted spider mite (Tetranychus bimaculatus Harvey)
Variegated cutworm (Peridroma margaritosa (Haw.))
Vegetable weevil (Listroderes obliquus Klug)

The armyworm, the celery leaf tier, the large milkweed bug, the pea aphid, and the variegated cutworm were reared in the laboratory; all others were collected in the field. The equipment and methods employed were essentially the same as those described by Swingle, Phillips, and Gahan (1).

In most of the tests with coleopterous or lepidopterous larvae 24 insects were used per test, a minimum of 20 milkweed bugs were used, and the number of aphids and mites ranged from around this minimum to several times the number. The test period was usually 2 days.

When received for testing, the samples had been diluted to 25, 10, or 5 percent in pyrophyllite and generally were in good physical condition for dusting.

Materials causing mortalities of 75 percent or higher as dusts were applied as sprays to the leaves of five or more kinds of plants to determine whether they would injure green foliage. The sprays contained 25-percent material applied at the rate of 8 pounds per 100 gallons of water to green foliage of plants growing under natural conditions.

The results of the tests with insecticides of known value against certain insects, made for comparative purposes, are presented in table 1.

Data on 27 compounds that caused greater than 74 percent mortality to one or more species of insects in dust tests are shown in table 2. Of these materials 20 were effective against the two-spotted spider mite.

On the basis of the number of species affected, the four most toxic compounds appear to be p-chloro-N,N-diisopropylbenzamide, 3,4-dichloro-N,N-diisopropylbenzamide, 3,4-dichloro-N,N-dimethylbenzamide, and 2-phenylhydrazide-o-chlorobenzoic acid.

The first three compounds named were effective both as contact and as stomach poisons, but 2-phenylhydrazide-o-chlorobenzoic acid was not effective as a contact poison against the insects tested. No appreciable injury to foliage resulted from spray applications of any of the four compounds. Compounds reported in table 2 that did show moderate toxicity to green foliage of one or more kinds of plants were N-amyl-3,4-dichlorobenzamide, 2,4-dichloro-N-ethylbenzamide, and 2,4-dichloro-N,N-dipropylbenzamide.

Table 3 presents results of tests against various insects with 29 compounds that gave kills between 25 and 74 percent. However, the only compounds that caused mortalities of 60 percent or higher were 3,4-dichloro-N-benzylbenzamide, p-chloro-N-sec-hexylbenzamide, 2-phenylhydrazide-3,4-dichlorobenzoic acid, and 2,4-dichlorobenzoyl-piperidine against the two-spotted spider mite, 2-phenylhydrazide-p-chlorobenzoic acid against the celery leaf tier, and 2',3,4,5'-tetra-chlorobenzanilide against the pea aphid.

The compounds that caused less than 25 percent mortality of the species against which they were tested are listed in table 4.

Literature Cited

- (1) Swingle, M.C., Phillips, A.M., and Gahan, J.B.
1941. Laboratory testing of natural and synthetic organic substances as insecticides. Jour. Econ. Ent. 34: 95-99.

Table 1. - - Effectiveness of four insecticides tested against various species of insects fed dusted foliage, to be used as standards for comparing results obtained with new insecticidal compounds

Compound	Insect	Stage	Foliage	Feeding	Average deposit		Average kill	
					per square centimeter	after - 2 days 3 days		
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	Percent				Micrograms	Percent	Percent	
Gamma benzene hexa-chloride (lindane)	5	Pea aphid	2-day-old nymphs	Windsor bean	-	215	86	-
	2	Cabbage aphid	Nymphs and adults	Orange leaf	-	95	100	-
	.5	Large milkweed bug	Second-instar nymphs	Milkweed seed	-	125	100	-
		Pea aphid	2-day-old nymphs	Windsor bean	-	110	100	-
	.2	Large milkweed bug	Third-instar nymphs	Milkweed seed	-	200	100	-
	.25	do.	do.	do.	-	140	70	-
	.125	Pea aphid	2-day-old nymphs	Windsor bean	-	75	92	-
		Armyworm	Fourth instar	Barley	Moderate	265	75	-
Bis(p-chlorophenoxy)-methane	2	Two-spotted spider mite	Nymphs and adults	Lima bean	-	185	-	75
	1	Citrus mite	Eggs	Orange fruit	-	250	10 in 7 days	78
		Two-spotted spider mite	Nymphs and adults	Castor bean	-	220	-	78
	.5	Citrus mite	do.	Orange fruit	-	295	100	-
O,O-Diethyl-O-p-nitrophenyl thiophosphate (parathion)	.5	do.	do.	do.	-	170	-	100
		do.	do.	do.	-	215	-	93
	.1	Two-spotted spider mite	do.	Castor bean	-	110	-	95
		do.	Eggs	do.	-	160	50 in 4 days	-
		do.	Nymphs and adults	do.	-	140	90	-
	.025	do.	do.	do.	-	170	-	78
	.0125	do.	do.	do.	-	185	-	87

Table 1. -- (Continued)

Compound	Percent	Insect	Stage	Foliage	Feeding	Average deposit		Percent	Percent
						per square centimeter	Average Kill after -		
							2 days	3 days	
1,1,1-Trichloro-2,2-bis(p-chlorophenyl)-ethane (DIT)	2.5	Amyworm	Third instar	Barley	None	235	-	-	96
		Celery leaf tier	Fourth instar	Swiss chard	Slight	155	-	-	100
		Green dock beetle	do.	Dock	Much	150	-	-	29
		Large milkweed bug	Nymphs	Milkweed seed	-	200	-	-	97
	2	Amyworm	Fourth instar	Corn leaves	Moderate	170	-	-	63
		Large milkweed bug	Nymphs	Milkweed seed	-	265	86	-	-
	1	Alder flea beetle	Third instar	Alder	Slight	355	-	-	100
		Celery leaf tier	do.	Swiss chard	do.	300	-	-	58
	.5	Alder flea beetle	do.	Alder	do.	230	-	-	100
		Amyworm	Fourth instar	Barley	Moderate	149	-	-	79
		California oakworm	do.	Oak leaves	Slight	110	-	-	100
		Celery leaf tier	do.	Swiss chard	do.	230	-	-	96
		Green dock beetle	do.	Dock	do.	150	-	-	100
		Pea aphid	2-day-old nymphs	Windsor bean	-	200	92	-	-
		Variogated cutworm	Fourth instar	Mulva	Slight	155	-	-	100
	.2	Celery leaf tier	Third instar	Swiss chard	do.	155	-	-	92

Table 2. - - Compounds causing greater than 74 percent mortality of one or more species of insects fed dusted foliage

Compound	Percent	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill	
						2 days	3 days
<u>Percent</u>							
Anthranilic acid, N-(p-chlorobenzoyl)-	25	Celery leaf tier	Fourth instar	Much	210	-	0
		Pea aphid	2-day-old nymphs	-	210	75	-
		Two-spotted spider mite	Nymphs and adults	-	200	0 in 4 days	-
Benzamide, N-sec-amyl-2,4-dichloro-	5	Amyworm	Third instar	Moderate	200	-	0
		Celery leaf tier	do.	Much	195	-	8
		Citrus mite	Nymphs and adults	-	200	-	0
		Green dock beetle	Fourth instar	Much	215	-	81
		Large milkweed bug	Third-instar nymphs	-	200	20	-
		Pea aphid	2-day-old nymphs	-	200	0	-
		Two-spotted spider mite	Nymphs and adults	-	215	-	77
Benzamide, N-amyl-3,4-dichloro-	25	Alder flea beetle	Third instar	Moderate	250	-	29
		Celery leaf tier	do.	do.	220	-	8
		Large milkweed bug	Second-instar nymphs	-	110	0	-
		Pea aphid	2-day-old nymphs	-	185	0	-
		Two-spotted spider mite	Nymphs and adults	-	220	-	78
Benzamide, N-sec-amyl-3,4-dichloro-	25	Alder flea beetle	Third instar	Slight	180	-	42
		Celery leaf tier	do.	Moderate	200	-	13
		Large milkweed bug	Second-instar nymphs	-	125	5	-
		Pea aphid	2-day-old nymphs	-	260	0	-
		Two-spotted spider mite	Nymphs and adults	-	250	-	88
Benzamide, p-chloro-N,N-diisobutyl-	25	Amyworm	Third instar	Moderate	265	0	-
		Celery leaf tier	do.	do.	265	29	-
		do.	Fourth instar	Much	300	-	8
		Large milkweed bug	Second-instar nymphs	-	215	0	-
		Pea aphid	2-day-old nymphs	-	295	64	-
		Two-spotted spider mite	Eggs	-	280	-	60
		do.	Nymphs and adults	-	220	-	96

Table 2. -- (Continued)

Compound	Percent	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill		
						2 days	3 days	after
Percent								
Micrograms								
Benzamide, p-chloro-N-ethyl-	25	Celery leaf tier	Fourth instar	Much	310	-	-	21
		Pea aphid	Nymphs and adults	-	250	-	-	10
		Two-spotted spider mite	do.	-	200	-	-	95
Benzamide, o-chloro-N-isopropyl-	25	Alder flea beetle	Third instar	Slight	385	-	-	92
		Armyworm	Fourth instar	do.	325	-	-	70
		Cabbage aphid	Nymphs and adults	-	250	14	-	-
		Celery leaf tier	Fourth instar	Moderate	260	-	-	10
		Large milkweed bug	Nymphs	-	220	-	-	25
		Two-spotted spider mite	Nymphs and adults	-	215	-	-	0
		Variiegated cutworm	Fourth instar	Much	325	-	-	8
Benzamide, p-chloro-N-diisopropyl-	25	California oakworm	do.	Slight	255	-	-	54
		Celery leaf tier	do.	do.	265	-	-	88
		Green dock beetle	do.	do.	220	-	-	67
		Pea aphid	2-day-old nymphs	-	210	90	-	-
		Two-spotted spider mite	Eggs	-	250	-	-	81
		do.	Nymphs and adults	-	250	-	-	100
		Vegetable weevil	Fourth instar	Much	285	-	-	4
Benzamide, p-chloro-N-isopropyl-	25	Celery leaf tier	do.	Much	220	-	-	17
		Pea aphid	2-day-old nymphs	-	200	79	-	-
		Two-spotted spider mite	Nymphs and adults	-	270	-	-	65
		do.	Eggs	-	310	-	-	100
		Vegetable weevil	Fourth instar	Much	320	-	-	0
Benzamide, 2,4-dichloro-5,N-diethyl-	5	Alder flea beetle	Third instar	Moderate	340	-	-	17
		Celery leaf tier	Fourth instar	Much	350	-	-	38
		Large milkweed bug	Second-instar nymphs	-	200	15	-	-
		Pea aphid	2-day-old nymphs	-	310	0	-	-
		Two-spotted spider mite	Nymphs and adults	-	200	-	-	100
		do.	do.	-	200	-	-	78

Table 2. - - (Continued)

Compound	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill	
					2 days	3 days
<u>Percent</u>						
Benzamide, 2,4-dichloro-N,N-diisobutyl-	5 Celery leaf tier	Fourth instar	Much	265	-	0
	Pea aphid	2-day-old nymphs	-	230	0	-
	Two-spotted spider mite	Nymphs and adults	-	200	-	100
	do.	do.	-	215	-	74
Benzamide, 2,4-dichloro-N,N-diisopropyl-	5 Celery leaf tier	Fourth instar	Much	265	-	8
	Pea aphid	2-day-old nymphs	-	230	26	-
	Two-spotted spider mite	Nymphs and adults	-	230	-	90
	do.	do.	-	265	-	64
Benzamide, 3,4-dichloro-N,N-diisopropyl-	25 Cabbage aphid	do.	-	250	65	-
	California oakworm	Fourth instar	Slight	260	-	21
	Celery leaf tier	do.	do.	235	-	92
	Large milkweed bug	Nymphs	-	200	5	-
	Two-spotted spider mite	Nymphs and adults	-	265	-	97
	do.	Eggs	-	250	-	100
Benzamide, 3,4-dichloro-N,N-dimethyl-	25 California oakworm	Fourth instar	Moderate	230	-	90
	Celery leaf tier	do.	do.	235	-	25
	Large milkweed bug	Nymphs	-	200	5	-
	Pea aphid	2-day-old nymphs	-	215	86	-
	Two-spotted spider mite	Eggs	-	265	-	100
	do.	Nymphs and adults	-	280	-	100
Benzamide, 2,4-dichloro-5-N,N-dipropyl-	Celery leaf tier	Fourth instar	Much	385	-	30
	Large milkweed bug	Second-instar nymphs	-	220	5	-
	Pea aphid	2-day-old nymphs	-	265	0	-
	Two-spotted spider mite	Nymphs and adults	-	340	-	100
	do.	do.	-	295	-	100

Table 2. - - (Continued)

Compound	Percent	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill	
						after - 2 days	3 days
<u>Percent</u>							
Benzamide, N,N-ethylenebis [2,4-dichloro-	5	Armyworm	Third instar	Much	200	-	0
		Celery leaf tier	do.	do.	200	-	4
		Green dock beetle	Fourth instar	do.	195	-	79
		Large milkweed bug	Third-instar nymphs	-	230	0	-
		Two-spotted spider mite	Nymphs and adults	-	250	-	0
Benzamide, 2,4-dichloro-N-ethyl-	5	Armyworm	Third instar	Moderate	215	-	0
		Celery leaf tier	Fourth instar	Much	265	-	50
		do.	Third instar	Moderate	215	-	0
		Pea aphid	2-day-old nymphs	-	220	0	-
		Two-spotted spider mite	Nymphs and adults	-	265	-	100
Benzamide, 2,4-dichloro-N-isopropyl-	5	do.	do.	-	325	-	100
		Alder flea beetle	Third instar	Moderate	325	-	50
		Armyworm	do.	do.	248	-	33
		Celery leaf tier	do.	do.	248	-	4
		do.	Fourth instar	do.	250	-	50
Benzamide, 2,4-dichloro-N-propyl-	5	Pea aphid	2-day-old nymphs	-	220	0	-
		Two-spotted spider mite	Nymphs and adults	-	310	-	95
		do.	do.	-	280	75	-
		Alder flea beetle	Third instar	Slight	295	-	58
		Celery leaf tier	Fourth instar	Much	295	-	29
Benzamide, 2,4-dichloro-N-ethyl-	5	Pea aphid	2-day-old nymphs	-	250	36	-
		Two-spotted spider mite	Nymphs and adults	-	250	-	100
		do.	do.	-	280	-	84
		Alder flea beetle	Third instar	Much	325	-	0
		Cabbage aphid	Nymphs and adults	-	280	20	-
Benzamide, 2,4-dichloro-N-ethyl-	25	Celery leaf tier	Fourth instar	Much	310	-	67
		Pea aphid	Nymphs	-	320	96	-
		Two-spotted spider mite	Nymphs and adults	-	340	8	-
		do.	do.	-	-	-	-
		do.	do.	-	-	-	-

Table 2. - - (Continued)

Compound	Percent	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill	
						2 days	3 days
Micrograms							
Percent							
Benzanilide, 3,4,4'-trichloro-	25	Alder flea beetle	Third instar	Moderate	295	-	21
		Celery leaf tier	do.	Much	280	-	4
		Large milkweed bug	Second-instar nymphs	-	170	10	-
		Pea aphid	2-day-old nymphs	-	230	82	-
		Two-spotted spider mite	Nymphs and adults	-	265	-	0
Benzenesulfonamide, 3,4-dichloro-N-methyl-	5	Amyworm	Third instar	None	250	100	-
		Celery leaf tier	do.	Slight	250	42	-
		do.	Fourth instar	Moderate	230	-	29
		Large milkweed bug	Second-instar nymphs	-	185	0	-
		Pea aphid	1-day-old nymphs	-	230	40 in 1 day	-
Two-spotted spider mite	Nymphs and adults	-	200	-	95		
m-Benzotoluide, 2-chloro-	25	Alder flea beetle	Third instar	Much	260	-	0
		Cabbage aphid	Nymphs and adults	-	220	13	-
		Celery leaf tier	Fourth instar	Moderate	280	-	4
		Pea aphid	Nymphs	-	280	97	-
		Two-spotted spider mite	Nymphs and adults	-	310	33	-
o-Chlorobenzoic acid, 2-phenylhydrazide	25	Alder flea beetle	Third instar	None	280	-	100
		Amyworm	Fourth instar	do.	310	-	80
		Celery leaf tier	do.	do.	270	-	96
		Large milkweed bug	Nymphs	-	235	-	0
		Two-spotted spider mite	Nymphs and adults	-	200	-	22
Variegated cutworm	Fourth instar	Moderate	310	-	71		
Morpholine, 4-(o-chlorobenzoyl)-	25	Amyworm	do.	do.	380	-	86
		Celery leaf tier	do.	Much	290	-	38
		Two-spotted spider mite	Nymphs and adults	-	215	-	23
		Variegated cutworm	Fourth instar	Much	380	-	0

Table 2. -- (Continued)

Compound	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill	
					after - 2 days	3 days
<u>Percent</u>						
Piperidine, 1-(<u>o</u> -chlorobenzoyl)-	25 Armyworm	Fourth instar	Much	250	11	-
	do.	do.	do.	230	-	8
	Celery leaf tier	do.	Moderate	290	-	17
	Two-spotted spider mite	Nymphs and adults	-	215	-	100
	Variegated cutworm	Fourth instar	Much	230	-	100
Piperidine, 1- (<u>p</u> -chlorobenzoyl)-	25 Celery leaf tier	do.	do.	230	-	21
	Pea aphid	2-day-old nymphs	-	250	0	-
	Two-spotted spider mite	Nymphs and adults	-	340	100	-
	do.	do.	-	230	-	65
	do.	Eggs	-	230	-	39

Table 3. - - Compounds causing from 25 to 74 percent mortality of one or more species of insects fed dusted foliage

Compound		Insect	Stage	Feeding	Average deposit per square centimeter	Average kill after -	
Percent						2 days	3 days
					Micrograms	Percent	
Benzamide, N-sec- amyl-o-chloro-	25	Celery leaf tier	Fourth instar	Much	295	-	16
		Pea aphid	Nymphs and adults	-	265	-	9
		Two-spotted spider mite	do.	-	200	-	54
Benzamide, N-sec- amyl-p-chloro-	25	Celery leaf tier	Fourth instar	Moderate	290	-	8
		Pea aphid	2-day-old nymphs	-	220	12	-
		Two-spotted spider mite	Nymphs and adults	-	310	-	47
Benzamide, N-benzyl- o-chloro-	25	Armyworm	Fourth instar	Slight	215	-	33
		Celery leaf tier	do.	Moderate	250	-	42
		Variegated cutworm	do.	Much	215	-	13
Benzamide, N-benzyl- 3,4-dichloro-	25	Celery leaf tier	Third instar	Moderate	280	-	4
		Large milkweed bug	Second-instar nymphs	-	170	0	-
		Pea aphid	2-day-old nymphs	-	250	0	-
		Two-spotted spider mite	Nymphs and adults	-	230	-	72
Benzamide, N-butyl- o-chloro-	25	Armyworm	Fourth instar	Moderate	230	-	8
		Celery leaf tier	do.	do.	460	-	54
		Variegated cutworm	do.	Much	230	-	8
Benzamide, N-butyl- 3,4-dichloro-	25	Cabbage aphid	Nymphs and adults	-	190	31	-
		Celery leaf tier	Fourth instar	Moderate	215	-	9
		Two-spotted spider mite	Nymphs and adults	-	200	-	0
Benzamide, N-sec- butyl-3,4-dichloro-	25	Cabbage aphid	do.	-	265	28	-
		Celery leaf tier	Fourth instar	Moderate	295	-	4
		Two-spotted spider mite	Nymphs and adults	-	295	-	0
Benzamide, o-chloro- N-cyclohexyl-	25	Celery leaf tier	Fourth instar	Moderate	265	-	58
		Pea aphid	Nymphs and adults	-	250	-	0

Table 3. -- (Continued)

Compound	Percent	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill after -		
						2 days	3 days	Percent
Benzamide, o-chloro- N-isobutyl-	25	Armyworm	Fourth instar	Moderate	230	-	-	33
		Celery leaf tier	do.	Much	260	-	-	17
		Variegated cutworm	do.	do.	230	-	-	8
Benzamide, o-chloro- N-propyl-	25	Armyworm	do.	Slight	340	-	-	39
		Celery leaf tier	do.	Moderate	430	-	-	54
		Variegated cutworm	do.	Much	340	-	-	29
Benzamide, p-chloro- N-sec-hexyl-	25	Celery leaf tier	do.	Moderate	230	-	-	17
		Pea aphid	2-day-old nymphs	-	260	23	-	-
		Two-spotted spider mite	Nymphs and adults	-	200	-	-	80
Benzamide, p-chloro- N-isobutyl-	25	Armyworm	Third instar	Moderate	250	0	-	-
		Celery leaf tier	do.	do.	250	17	-	-
		Pea aphid	2-day-old nymphs	-	185	26	-	-
		Two-spotted spider mite	Nymphs and adults	-	325	0	-	-
Benzamide, 3,4- dichloro-N,N- diisobutyl-	25	Cabbage aphid	Third instar	-	250	23	-	-
		Celery leaf tier	Fourth instar	Moderate	250	-	-	19
		Two-spotted spider mite	Nymphs and adults	-	310	-	-	44
		Cabbage aphid	do.	-	310	30	-	-
Benzamide, 3,4- dichloro-N- isopropyl-	25	Celery leaf tier	Fourth instar	Moderate	265	-	-	17
		Two-spotted spider mite	Nymphs and adults	-	265	-	-	0
		Cabbage aphid	do.	-	200	44	-	-
		Celery leaf tier	Fourth instar	Moderate	330	-	-	21
Benzamide, 2'-chloro- 3,4-dichloro- Propyl-	5	Two-spotted spider mite	Nymphs and adults	-	250	-	-	0
		Celery leaf tier	Fourth instar	Much	265	-	-	0
		Pea aphid	2-day-old nymphs	-	215	31	-	-
		Two-spotted spider mite	Nymphs and adults	-	200	-	-	0

Table 3. - - (Continued)

Compound	Percent	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill after -		
						2 days	3 days	Percent
Benzanilide, 2-chloro- 3'-nitro-	25	Celery leaf tier	Fourth instar	Much	370	-	-	46
		Pea aphid	Nymphs	-	265	26	-	-
		Two-spotted spider mite	Nymphs and adults	-	355	13	-	-
Benzanilide, 4-chloro- 4'-phenylazo-	25	Celery leaf tier	Fourth instar	Moderate	220	-	-	13
		Pea aphid	2-day-old nymphs	-	300	42	-	-
		Two-spotted spider mite	Nymphs and adults	-	250	0 in 4 days	-	-
Benzanilide, 2,4'- dichloro-	25	Celery leaf tier	Fourth instar	Much	250	-	-	46
		Pea aphid	Nymphs	-	265	0	-	-
		Two-spotted spider mite	Nymphs and adults	-	220	4	-	-
Benzanilide, 3,4- dichloro-2'-nitro-	25	Celery leaf tier	Fourth instar	Moderate	340	-	-	0
		Pea aphid	2-day-old nymphs	-	265	19	-	13
		Two-spotted spider mite	Nymphs and adults	-	265	-	27	1
Benzanilide, 3,4- dichloro-3'-nitro-	5	Celery leaf tier	Fourth instar	Much	265	-	-	0
		Pea aphid	2-day-old nymphs	-	280	58	-	-
		Two-spotted spider mite	Nymphs and adults	-	265	-	-	0
Benzanilide, o'- hydroxy-	25	Celery leaf tier	Fourth instar	Much	260	-	-	4
		Pea aphid	2-day-old nymphs	-	250	26	-	-
		Two-spotted spider mite	Nymphs and adults	-	235	0 in 4 days	-	-
Benzanilide, 2', 3,4,5'-tetrachloro-	25	Celery leaf tier	Third instar	Much	265	-	-	0
		Pea aphid	2-day-old nymphs	-	230	64	-	-
		Two-spotted spider mite	Nymphs and adults	-	250	-	-	0
o-Benzanilide, p'- chloro-	25	Celery leaf tier	Fourth instar	Moderate	240	-	-	9
		Pea aphid	2-day-old nymphs	-	220	33	-	-
		Variegated cutworm	Third instar	Moderate	295	-	-	0

Table 3. -- (Continued)

Compound	Insect	Stage	Feeding	Average deposit per square centimeter	Average kill		
					Percent	Percent	Percent
p-Toluenamide, 2,4-dichloro-	5 Celery leaf tier	Third instar	Much	210	-	29	
	Pea aphid	Adults	-	215	0	-	
	Two-spotted spider mite	Nymphs and adults	-	215	0	-	
m-Benzotoluide, 2,4-dichloro-	5 Celery leaf tier	Fourth instar	Much	350	-	42	
	Pea aphid	2-day-old nymphs	-	200	0	-	
	Two-spotted spider mite	Nymphs and adults	-	310	-	10	
p-Chlorobenzoic acid, 1-phenylhydrazide	25 Celery leaf tier	Third instar	Moderate	230	-	67	
	Pea aphid	Nymphs	-	280	0	-	
	Two-spotted spider mite	Nymphs and adults	-	265	7	-	
2,4-Dichlorobenzoic acid, 2-phenylhydra- zide	25 Celery leaf tier	Third instar	Moderate	340	-	21	
	Pea aphid	2-day-old nymphs	-	230	0	-	
	Two-spotted spider mite	Nymphs and adults	-	310	-	64	
Piperidine, 2,4- dichlorobenzoyl-	5 Celery leaf tier	Fourth instar	Moderate	200	-	25	
	Pea aphid	2-day-old nymphs	-	265	0	-	
	Two-spotted spider mite	Nymphs and adults	-	230	-	39	
	do.	do.	-	250	-	67	

Table 4. - - Chlorinated benzamides that were found to be practically nontoxic, killing less than 25 percent of insects fed dusted foliage

Compound		Insect	Stage
	<u>Percent</u>		
Anthranilic acid, N-(2,4-dichloro-benzoyl)-	5	Armyworm	Third instar
		Celery leaf tier	do.
		Large milkweed bug	Third-instar nymphs
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-amyl-o-chloro-	25	Armyworm	Fourth instar
		Celery leaf tier	do.
		Large milkweed bug	Third-instar nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-amyl-p-chloro-	25	Celery leaf tier	Third instar nymphs
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-amyl-2,4-dichloro-	5	Celery leaf tier	Fourth instar
		Pea aphid	2-day old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-benzyl-p-chloro-	25	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-benzyl-2,4-dichloro-	5	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-sec-butyl-o-chloro-	25	Armyworm	Fourth instar
		Celery leaf tier	do.
		Variegated cutworm	do.
Benzamide, N-butyl-p-chloro-	25	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-sec-butyl-p-chloro-	25	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzamide, N-butyl-2,4-dichloro-	5	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults

Table 4. - - (Continued)

Compound		Insect	Stage
	<u>Percent</u>		
Benzamide, N-sec-butyl- 2,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, p-chloro-N-2- bicyclohexyl-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, p-chloro-N- cyclohexyl-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, p-chloro-N- heptyl-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, p-chloro-N- propyl-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, N,N-dibenzyl- o-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, N,N-dibenzyl- p-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, N,N-dibenzyl- 3,4-dichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzamide, N,N-dibutyl- 2,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, 2,4-dichloro-N- 2-bicyclohexyl-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar Adults Nymphs and adults
Benzamide, 2,4-dichloro-N- cyclohexyl-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzamide, 3,4-dichloro-N- cyclohexyl-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults

Table. 4 - - (Continued)

Compound		Insect	Stage
	<u>Percent</u>		
Benzamide, 2,4-dichloro-N-isobutyl-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzamide, 3,4-dichloro-N-isobutyl-	25	Cabbage aphid Celery leaf tier Two-spotted spider mite	do. Fourth instar Nymphs and adults
Benzanilide, 4'-benzoyl-4-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2'-bromo-2,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzanilide, 4'-bromo-2-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
Benzanilide, 4'-bromo-4-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs All stages
Benzanilide, 4'-bromo-2,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar Adult Nymphs
Benzanilide, 4'-bromo-3,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar Nymphs Nymphs and adults
Benzanilide, 2-chloro-2'-nitro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
Benzanilide, 4-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzanilide, 4-chloro-2'-nitro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults

Table 4. - - (Continued)

Compound		Insect	Stage
	<u>Percent</u>		
Benzanilide, 4-chloro-3'-nitro-	25	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 4-chloro-4'-nitro-	25	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,2'-dichloro-	25	Celery leaf tier	Third instar
		Pea aphid	Nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,3-dichloro-	25	Celery leaf tier	Fourth instar
		Pea aphid	Nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2',4-dichloro-	25	Celery leaf tier	Fourth instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,4-dichloro-	5	Armyworm	Third instar
		Celery leaf tier	do.
		Green dock beetle	Fourth instar
		Large milkweed bug	Third-instar nymphs
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,4-dichloro-2'-nitro-	5	Celery leaf tier	Third instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,4-dichloro-3'-nitro-	5	Celery leaf tier	Third instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,4-dichloro-4'-nitro-	5	Celery leaf tier	Third instar
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults
Benzanilide, 2,4-dichloro-4'-phenylazo-	5	Armyworm	Third instar
		Celery leaf tier	do.
		Green dock beetle	Fourth instar
		Large milkweed bug	Third-instar nymphs
		Pea aphid	2-day-old nymphs
		Two-spotted spider mite	Nymphs and adults

Table 4. - - (Continued)

Compound		Insect	Stage
	<u>Percent</u>		
Benzanilide, 3',4-dichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzanilide, 4,4'-dichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzanilide, 3,4-dichloro-4'-nitro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2,4-dichloro-2'-phenyl-	5	Armyworm Celery leaf tier Green dock beetle Large milkweed bug Pea aphid Two-spotted spider mite	Third instar do. Fourth instar Third-instar nymphs 2-day-old nymphs Nymphs and adults
Benzanilide, 2,2',4,5'-tetrachloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2,2',4-trichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2,2',5'-trichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
Benzanilide, 2',3,4-trichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2,3',4-trichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third-instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2,4,4'-trichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
Benzanilide, 2',4,5'-trichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults

Table 4. - - (Continued)

Compound		Insect	Stage
	<u>Percent</u>		
Benzanilide, 3,3',4-trichloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults
<u>o</u> -Benzanilide, 2-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
<u>p</u> -Benzanilide, 2-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
<u>p</u> -Benzanilide, 4-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite Variegated cutworm	Fourth instar 2-day-old nymphs Nymphs and adults Third instar
<u>o</u> -Benzanilide, 2,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	do. Adults Nymphs and adults
<u>p</u> -Benzanilide, 3,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Benzoic acid, 2,4-dichloro-, 2-phenylhydrazide	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
<u>o</u> -Benzotoluide, 2-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
<u>p</u> -Benzotoluide, 2-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
<u>m</u> -Benzotoluide, 4-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
<u>o</u> -Benzotoluide, 4-chloro	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
<u>p</u> -Benzotoluide, 4-chloro-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults

Table 4. - - (Continued)

Compound		Insect	Stage
	<u>Percent</u>		
<u>m</u> -Benzotoluide, 2,4-dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar Adults Nymphs and adults
<u>p</u> -Benzotoluide, 2,4- dichloro-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar Adults Nymphs and adults
Morpholine, 4- (<u>p</u> -chlorobenzoyl)-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar Nymphs Nymphs and adults
Morpholine, 2,4- dichlorobenzoyl-	5	Celery leaf tier Pea aphid Two-spotted spider mite	Fourth instar 2-day-old nymphs Nymphs and adults
Morpholine, 3,4- dichlorobenzoyl-	25	Celery leaf tier Pea aphid Two-spotted spider mite	Third instar 2-day-old nymphs Nymphs and adults

